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## Irregular Growth of Outplanted Red Pine I. The Influence of Nursery Herbicidal Practices

by

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Since early 1970 abnormal leader development and some reduction in survival have been observed in freshly outplanted red pine (*Pinus resinosa* Ait.) by several Ministry employees. This condition always occurs only after outplanting. The abnormal development ranges from a non-elongated terminal bud to an elongated terminal leader that has needles either along its length or as a tuft near its tip. These needles are always considerably shorter than those needles formed the previous year in the nursery. The non-elongated bud has a silvery appearance by summer and is frequently referred to as "silver bud". The most frequent abnormality is the elongated terminal leader with the needle tuft near its tip.

Preliminary surveys did not single out a causal factor. Consequently, factors such as herbicidal practices at the nursery, handling of stock and outplanting are being studied. The effects of nursery herbicidal practices are reported here.

### Procedures

In late fall, 1975, red pine were collected for herbicide residue analysis from 20 areas, which were planted with 3+0 red pine that spring in 6 districts (Cambridge, Maple, Lindsay, Tweed, Lanark, Pembroke). They were collected from areas where no chemical site preparation was involved. At the same time, samples of current 3+0 red pine were collected from the nurseries involved: Kemptville, Midhurst and Orono.

The outplanted trees were divided into 3 classes: 1) good, the elongated terminal leader had needles along the entire leader; 2) medium, the elongated terminal leader had only a needle tuft; and 3) dead, of which some had died before, some after leader elongation. Both outplanted and nursery trees were put in plastic bags, stored in a cooler and transported to Maple. Here, the trees were divided into 1975 needles, 1975 leader growth, 1974 needles, 1974 leader growth on the stem, and roots; the remaining portion was discarded. These samples (209 in total) were analysed at the Provincial Pesticide Residue Testing Laboratory<sup>1</sup>, Ontario Ministry of Agri-

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culture and Food, Guelph, for simazine (2-chloro-4, 6-bis (ethylamino)-s-triazine) and dacthal (DCPA; dimethyl tetrachloroterephthalate) residues. Twenty-five field samples were also tested for maneb residues because this fungicide was used on red pine in the nurseries against *Lophodermium* (needle cast).

The amounts and years of dacthal and simazine application to the nursery beds from which the outplanted red pine came are given in Table 1.

TABLE 1 Average herbicide amount (kg/ha)<sup>a</sup> applied in the nurseries to the outplanted red pine

| Nursery      | Herbicide    | Year              |       |      |      | Total |
|--------------|--------------|-------------------|-------|------|------|-------|
|              |              | 1971 <sup>b</sup> | 1972  | 1973 | 1974 |       |
| Kemptonville | Dacthal 75W  | 6.72              | 13.44 | --   | --   | 20.16 |
|              | Simazine 80W | --                | 2.24  | 1.46 | 0.78 | 4.48  |
| Midhurst     | Dacthal 75W  | 5.60              | --    | 5.60 | 5.60 | 16.80 |
| Orono        | Dacthal 75W  | 5.60              | 10.08 | 3.36 | 6.72 | 25.76 |

<sup>a</sup> 1 kg/ha = 0.89 lb/acre

<sup>b</sup> Applied in the fall at time of sowing

### Results and Discussion

No trace of simazine or maneb was detected in any sample, in contrast to dacthal. The concentrations of dacthal residues found are presented on an oven-dry basis in Figure 1. The standard error bars are given to indicate the variation that occurred between the samples. The means were compared by standard t-test procedures. The results of the entire tree were obtained by pooling the results of the various tissue components (discarded portion excluded).

The dacthal residue concentrations in the entire tree (Fig. 1a) for Kemptonville outplanted stock were significantly lower than those for Orono and Midhurst while the differences between the latter two were not significant. The stock collected directly from Midhurst nursery had an extremely high dacthal concentration, probably because these trees received one application of dacthal in 1975, while those at Kemptonville and Orono did not. Much of this dacthal may have been on the outside surfaces of the trees.

The dacthal concentrations in the various components and classes of trees that originated from Orono demonstrate how this herbicide was distributed within the trees (Fig. 1b). The 1975 needles did not contain any residues. Most of the dacthal residues occurred in the 1974 stem portion, while the roots contained the least. The distribution pattern within trees originating from Midhurst and Kemptonville trees was similar, although differing in magnitude.

On the entire tree basis, the good trees from Midhurst and Orono had significantly lower dacthal concentrations than the dead trees, but this was not true for Kemptonville trees. However, the dacthal concentrations in the good trees were diluted by their growth. Therefore, death or poor performance of

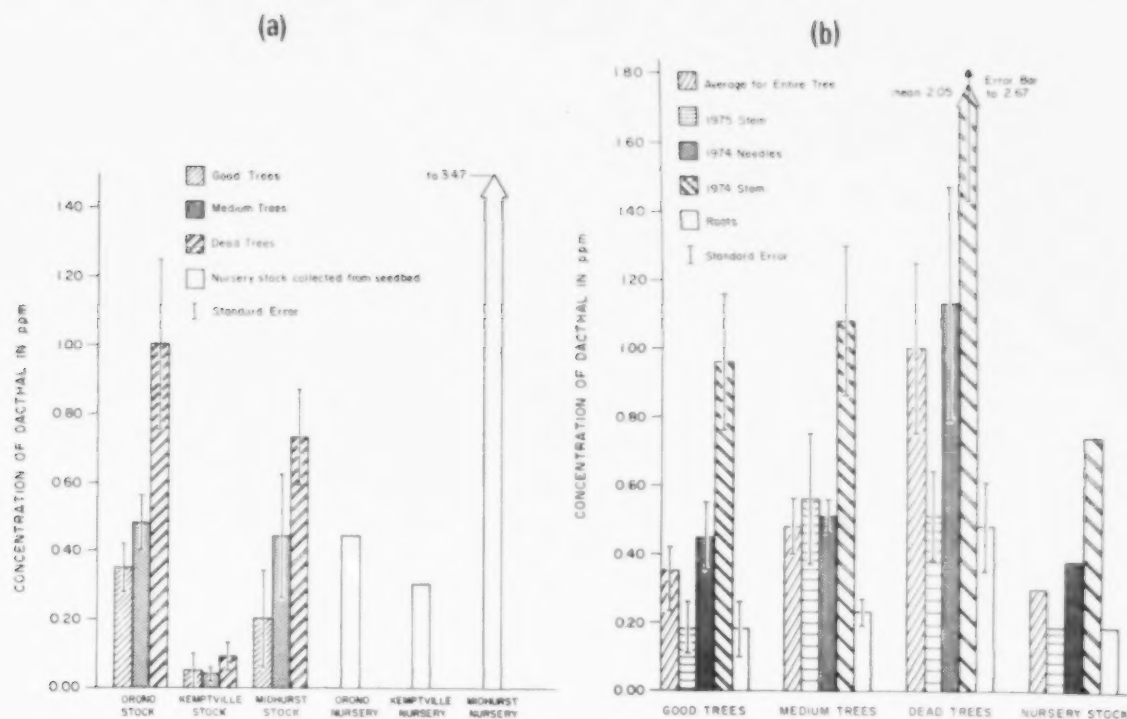


Figure 1 The average dacthal concentration in outplanted and nursery stock for (a) the entire tree from Orono, Kemptville and Midhurst, and (b) for the various components of the Orono trees. There are no significant differences between means where the error bars overlap. Error bars for the stock collected from the nurseries are absent because it was analysed as one sample.

the trees cannot be directly attributed to dacthal concentrations. Variability in tolerance to dacthal probably exists, but at present little is known about this.

The Herbicide Handbook of the Weed Science Society of America (1974) states that dacthal is not absorbed by foliage, not translocated in the plant and its average half life is 100 days in most general soil types. But our results indicate that dacthal is persistent in the tree and appears to be translocated. In Kemptville stock dacthal was still detectable more than 3 years after application and in the Midhurst and Orono outplanted stock it was detectable more than 1 year after application (Fig. 1a). The high concentration of dacthal in the 1974 needles and height increment suggests that it is absorbed by the foliage as well as by the roots (Fig. 1b). It is also apparently translocated, because the last applications of dacthal occurred in 1974 at Orono and Midhurst and in 1972 at Kemptville, yet it was found in the 1975 growth. These discrepancies between the Herbicide Handbook and our results are probably due because information in the Handbook is applicable mainly to herbaceous crops which have short rotations (weeks), while tree seedlings remain in the nursery for two to four years.

The abnormal development of red pine has been attributed to drought by some Ministry employees. The poor needle elongation is a typical symptom of moisture stress because pine needles are sensitive to even slight moisture

stresses (Larson 1963, Glerum and Pierpoint 1968). Internal plant moisture stress can exist even when soil moisture is adequate if the root system of the tree is deficient or contact with the soil is inadequate. It is this which we think might be a major factor in the abnormal development. The formation of new roots after outplanting could be poor, causing internal moisture stresses to be augmented. It is possible that dacthal lowers the root regeneration potential of red pine, similar to its inhibiting effect on root development, but not on stem growth, of rising 1-year-old white spruce (Kong and Day 1974). The meristematic tissues, which include root tips, shoot apex, intercalary meristems and vascular cambium, are primary sites of injury by dacthal (Frear 1976). Perhaps root meristems have a considerably lower tolerance level to dacthal than shoot meristems. It is also possible that damage to the red pine shoot apex affects root growth initiation, because the need for some kind of stimulus from the growing shoot to initiate root growth appears to be greater in red pine than in some other species (Wilcox 1968). However, since we know little about herbicide tolerance levels in trees and shoot-root relationships, these possibilities remain hypothetical.

### Conclusions

At present the abnormal development of freshly outplanted red pine cannot be attributed to herbicides, partly because we lack information on the interaction between herbicides and trees. Available information on herbicides is applicable mainly to herbaceous crops. These have short rotations, measured in weeks, while trees remain in the nursery for two to four years. This should be kept in mind when information on herbicides is used. Dacthal might have a detrimental effect on root regeneration potential and could be involved in the abnormal development of red pine.

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